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Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Office Action Summary	Application No. 09/590,464	Applicant(s) THAKUR, RANDHIR P. S.	
	Examiner Wesley D Markham	Art Unit 1762	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-49* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-26 and 29-49* is/are rejected.

7)☒ Claim(s) *27 and 28* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *09 June 2000* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☒ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Oath/Declaration

1. The oath or declaration is defective. A new oath or declaration in compliance with 37 CFR 1.67(a) identifying this application by application number and filing date is required. See MPEP §§ 602.01 and 602.02.
2. The oath or declaration is defective because it states that the inventor, Randhir Thakur, is a joint inventor, and it appears that Randhir Thakur is the sole inventor.

Drawings

3. This application has been filed with informal drawings, specifically Figures 3 and 4, which are acceptable for examination purposes only. Formal drawings will be required when the application is allowed.

Specification

4. The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed.
5. The following title is suggested: "Pulsed Precursor Deposition Process For Forming Layers in Semiconductor Devices".
6. The abstract of the disclosure is objected to because the statement, "such that the fluid is completed exhausted or removed from the chamber..." is improper grammar. Applicant is suggested to change the statement to read, "such that the fluid is

completely exhausted or removed from the chamber..." Correction is required. See MPEP § 608.01(b).

Claim Rejections - 35 USC § 112

7. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

8. Claims 11 – 12 and 37 – 39 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.
9. Specifically, the limitation that the solid layer (1) comprises a dielectric material (Claims 11 and 39), (2) comprises a conductive material (Claims 12 and 37), or (3) comprises a semiconductor material (Claim 38) is vague and indefinite. It is unclear as to what specific materials are included in the groups "dielectric material", "conductive material", and "semiconductor material."

Claim Rejections - 35 USC § 102

10. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

11. Claims 1 – 4, 8, 10, 16, 18 – 19, and 46 – 48 are rejected under 35 U.S.C. 102(e) as being anticipated by DiMeo, Jr. et al. (USPN 5,972,430).

12. Regarding Claim 1, DiMeo, Jr. et al. teach a process for forming layers in electronic devices (Col.1, line 14), the process comprising the steps of providing a reaction chamber, placing a substrate in the reaction chamber, pulsing a precursor fluid into the reaction chamber (Abstract and Figs. 1 – 3), exposing the precursor fluid to light energy in the reaction chamber causing the precursor fluid to convert into a solid layer on the substrate (Cols. 8 – 10, especially Col.10, lines 53 – 64), wherein the precursor fluid is substantially exhausted and removed from the reaction chamber in between each pulse of the precursor fluid (Figs. 2 – 3 and Cols. 9 – 10).

13. DiMeo, Jr. et al. also teach all the limitations of Claims 2 – 4, 8, 10, 16, and 18 – 19 as set forth above in paragraph 12 and below, including a process wherein:

- Claim 2 – The precursor fluid comprises a liquid vapor (Col.8, lines 22 – 47).
- Claim 3 – The precursor fluid comprises a gas (Col.8, lines 22 – 47).
- Claim 4 – The substrate comprises a semiconductor wafer (Col.11, lines 53 – 55).
- Claim 8 – The reaction chamber is maintained at a pressure less than atmospheric pressure when pulsing the precursor fluid into the reaction chamber (Col.10, lines 45 – 47).

- Claim 10 – An inert gas is flowed through the reaction chamber in between pulses of the precursor fluid in order to purge the remaining precursor fluid from the reaction chamber (Figs. 2 – 3 and Cols. 9 – 10).
- Claim 16 – The solid layer comprises a material selected from the group consisting of zirconium oxide, aluminum oxide, a nitride, barium strontium titanate (BST), and a silicate (Col.7, line 26).
- Claim 18 – The chamber pressure is less than about 5 Torr when pulsing the precursor fluid into the reaction chamber (Col.10, lines 45 – 47).
- Claim 19 – The substrate is maintained at a temperature of at least 100° C during formation of the solid layer (Col.10, lines 48 – 52).

14. Regarding Claim 46, DiMeo, Jr. et al. teach a process for forming layers in electronic devices comprising the steps of providing a reaction chamber, placing a semiconductor wafer into the reaction chamber, feeding a precursor fluid into the reaction chamber while the reaction chamber is at a pressure of less than 1 torr, and exposing the precursor fluid to an energy source in the reaction chamber causing the precursor fluid to convert into a solid layer on the semiconductor wafer (Figs. 1 – 3 and Cols. 8 – 10, especially Col.10, lines 40 – 64).
15. DiMeo, Jr. et al. also teach all the limitations of Claims 47 – 48 as set forth above in paragraph 14 and below, including a process wherein:

- Claim 47 – The reaction chamber is at a pressure of about 10^{-2} torr to about 10^{-7} torr when feeding the precursor fluid into the reaction chamber (Col.10, lines 45 – 47).
- Claim 48 – The energy source comprises light energy (Col.10, lines 53 – 64).

16. Claims 1, 3 – 5, 7 – 8, 11, 14, 18 – 19, and 46 – 49 are rejected under 35 U.S.C. 102(b) as being anticipated by Nishizawa et al. (USPN 5,443,033).
17. Regarding Claim 1, Nishizawa et al. teach a process for forming layers in electronic devices (Col.2, lines 4 – 6), the process comprising the steps of providing a reaction chamber, placing a substrate in the reaction chamber, pulsing a precursor fluid into the reaction chamber (Figs. 1, 4, and 5, and Cols. 4 – 5), exposing the precursor fluid to light energy in the reaction chamber causing the precursor fluid to convert into a solid layer on the substrate (Col.5, lines 1 – 7, and Col.6, lines 22 – 28), wherein the precursor fluid is substantially exhausted and removed from the reaction chamber in between each pulse of the precursor fluid (Cols.4 – 5, especially Col.4, lines 52 – 68, and Col.5, lines 1 – 32).
18. Nishizawa et al. also teach all the limitations of Claims 3 – 5, 7 – 8, 11, 14, and 18 – 19 as set forth above in paragraph 17 and below, including a method wherein:
    - Claim 3 – The precursor fluid comprises a gas (Col.6, lines 22 – 28).
    - Claim 4 – The substrate comprises a semiconductor wafer (Col.4, lines 52 – 56).

- Claim 5 – The substrate is heated with an electrical resistance heater during the formation of the layer (Col.4, lines 33 – 39 and 60 – 61).
- Claim 7 – The light energy is supplied by light energy sources positioned outside the reaction chamber (Figs. 1 and 10, reference number 14).
- Claim 8 – The reaction chamber is maintained at less than atmospheric pressure (Col.4, line 57).
- Claim 11 – The solid layer comprises a dielectric material (Col.5, lines 1 – 7).
- Claim 14 – The precursor fluid comprises a hydride (Col.4, line 66, and Col.5, line 22).
- Claim 18 – The reaction chamber is maintained at a pressure of less than about 5 torr (Col.4, line 57, and Col.5, line 1).
- Claim 19 – The substrate is maintained at a temperature of at least 100° C during formation of the solid layer (Col.4, lines 60 – 61).

19. Regarding Claim 46, Nishizawa et al. teach a process for forming layers in electronic devices comprising the steps of providing a reaction chamber, placing a semiconductor wafer into the reaction chamber, feeding a precursor fluid into the reaction chamber while the reaction chamber is at a pressure of less than 1 torr, and exposing the precursor fluid to an energy source in the reaction chamber causing the precursor fluid to convert into a solid layer on the semiconductor wafer (Figs. 1 and 10, and Cols. 4 – 6).

20. Nishizawa et al. also teach all the limitations of Claims 47 – 49 as set forth above in paragraph 19 and below, including a method wherein:

- Claim 47 – The reaction chamber is at a pressure of about 10^{-2} torr to about 10^{-7} torr when feeding the precursor fluid into the reaction chamber (Col.4, line 64, and Col.5, line 1).
- Claim 48 – The energy source comprises light energy (Col.5, lines 1 – 7, and Col.6, lines 22 – 28).
- Claim 49 – The energy source comprises a combination of light energy and thermal energy emitted by an electrical resistance heater (Col.4 and Col.5, lines 1 – 7).

Claim Rejections - 35 USC § 103

21. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

22. Claims 9 and 11 – 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over DiMeo, Jr. et al. (USPN 5,972,430).

23. DiMeo, Jr. et al. teach all the limitations of Claim 9 as set forth in paragraph 12 above, except a process wherein the light energy is pulsed is substantial synchronization with the precursor fluid. However, DiMeo, Jr. et al. do teach that the

light activation is used in the deposition of the precursor layer and the oxidation of the precursor layer steps (i.e., when precursor gases are flowing) (Col.10, lines 53 – 64). DiMeo, Jr. et al. do not make any mention of utilizing the light energy during, for example, the inert gas purging steps. Therefore, it would have been obvious to one of ordinary skill in the art to pulse the light energy of DiMeo, Jr. et al. in synchronization with the precursor fluid pulses with the reasonable expectation of successfully aiding the deposition of the precursor layers as desired and taught by DiMeo, Jr. et al.

24. DiMeo, Jr. et al. teach all the limitations of Claims 11 – 12 as set forth in paragraph 12 above, except a process wherein the deposited layer comprises a dielectric material (Claim 11) or a conductive material (Claim 12). However, DiMeo, Jr. et al. do teach a number of multi-component oxide thin film compositions (Col.7, lines 19 – 38). It would have been obvious to one of ordinary skill in the art that, depending on the specific multi-component oxide composition deposited by the process of DiMeo, Jr. et al., the deposited layer would have comprised a "dielectric material", a "conductive material", or both.

25. Claims 5 – 7 and 49 are rejected under 35 U.S.C. 103(a) as being unpatentable over DiMeo, Jr. et al. (USPN 5,972,430) in view of Murota et al. (USPN 5,705,224).

26. DiMeo, Jr. et al. teach all the limitations of Claim 5 as set forth in paragraph 12 above, except for a process further comprising the step of heating the substrate with an electrical resistance heater during the formation of the deposited layer. DiMeo, Jr.

et al. do teach that the substrate is heated to a temperature of from about 400 to 800° C during the deposition but are silent as to how the substrate is heated (Col.10, lines 50 – 52). Murota et al. teach a similar photo-induced ALD process in which the substrate is successfully heated through the use of an electrical resistance heater placed adjacent to the substrate (Col.4, lines 24 – 37, and Figure 1, reference numbers 11 – 12). It would have been obvious to one of ordinary skill in the art to heat the substrate of DiMeo, Jr. et al. with the electrical resistance heater of Murota et al. with the reasonable expectation of successfully heating the substrate as desired by DiMeo, Jr. et al. and taught by Murota et al. through the use of an electrical resistance heater.

27. DiMeo, Jr. et al. teach all the limitations of Claim 6 as set forth in paragraphs 12 and 26 above, except for a process wherein the reaction chamber has walls maintained at a temperature lower than the substrate during the layer formation. However, as the combination of DiMeo, Jr. et al. and Murota et al. teach the use of an electrical resistance heater that heats the substrate directly to a desired temperature, it would have been obvious to one of ordinary skill in the art that the walls of the reaction chamber, which are not directly heated, would have a lower temperature than the substrate, which is directly heated.

28. DiMeo, Jr. et al. teach all the limitations of Claim 7 as set forth in paragraph 12 above, except for a process wherein the light energy is supplied by light energy sources positioned outside the reaction chamber. DiMeo, Jr. et al. are silent as to the placement of the light sources. Murota et al. teach a similar photo-induced ALD

process wherein the light sources are positioned outside the reaction chamber (Figure 1 and Col.5, lines 1 – 5). It would have been obvious to one of ordinary skill in the art to position the light sources of DiMeo, Jr. et al. outside the reaction chamber as taught by Murota et al. with the reasonable expectation of successfully treating the layer with light energy as desired by DiMeo, Jr. et al. without contaminating the light sources by placing the light sources outside the deposition chamber as taught by Murota et al.

29. DiMeo, Jr. et al. teach all the limitations of Claim 49 as set forth in paragraphs 14 – 15 above, except for a process wherein the thermal energy is emitted by an electrical resistance heater (Col.10, lines 53 – 64). It would have been obvious to one of ordinary skill in the art to use an electrical resistance heater to heat the substrate of DiMeo, Jr. et al. as taught by Murota et al. for the reasons set forth in paragraph 26 above.

30. Claims 31 – 32, 34 – 39, and 41 – 44 are rejected under 35 U.S.C. 103(a) as being unpatentable over DiMeo, Jr. et al. (USPN 5,972,430) in view of Hayashi et al. (USPN 5,965,219) or Thakur (USPN 5,863,327).

31. DiMeo, Jr. et al. teach all the limitations of Claim 31 as set forth in paragraphs 12 and 13 above, except for a process comprising annealing the solid layer by exposing the solid layer to light energy. However, DiMeo, Jr. et al. teach that their process is used to deposit a number of multi-component oxide films (Col.7, lines 8 – 38). Both Hayashi et al. and Thakur teach that, after depositing the type of oxide films taught

by DiMeo Jr. et al., it is desirable to anneal the film with UV radiation in order to increase the quality of the film and reduce the impurities in the film (Abstract and Col.6, lines 54 – 65 of Hayashi et al., and Abstract and Col.5, lines 31 – 47 of Thakur). Therefore, it would have been obvious to one of ordinary skill in the art to anneal the layers of DiMeo, Jr. et al. with UV radiation as taught by either Hayashi et al. or Thakur with the reasonable expectation of increasing the quality of the film and reducing the impurities in the film as taught by Hayashi et al. and Thakur.

32. The combination of DiMeo, Jr. et al. and either Hayashi et al. or Thakur teach all the limitations of Claims 32, 34 – 39 and 41 – 44 as set forth above in paragraph 31 and below, including a method wherein:

- Claim 32 – The precursor fluid is first pulsed into the reaction chamber followed by a pulse of inert gas (Figs. 2 – 3 or DiMeo, Jr. et al.), and the light energy is emitted into the reaction chamber in synchronicity with the pulse of precursor fluid and during the annealing step but not during the pulse of inert gas (See paragraphs 23 and 31 above).
- Claim 34 – The reaction chamber is maintained at a pressure of less than about 5 torr (Col.10, line 48 of DiMeo, Jr. et al.).
- Claim 35 - The reaction chamber is maintained at a pressure of less than about 3 torr (Col.10, line 48 of DiMeo, Jr. et al.).
- Claim 36 – The precursor fluid comprises a mixture of gases (Col.8, lines 4 – 9).

- Claims 37 – 39 – The solid layer comprises a conductive, semiconductive, or dielectric material (Col.7, lines 19 – 38, and see paragraph 24 above).
- Claim 41 – The solid layer comprises a material selected from the group consisting of zirconium oxide, aluminum oxide, a nitride, barium strontium titanate, and a silicate (Col.7, lines 19 – 38).
- Claim 42 – The semiconductor wafer is maintained at a temperature of at least 100° C during the annealing step (Col.4, lines 66 – 67, and Col.5 of Thakur).
- Claim 43 – The reaction chamber is maintained at a pressure of about 10^{-2} torr to about 10^{-7} torr when pulsing the precursor fluid into the reaction chamber (Col.10, line 48).
- Claim 44 - The semiconductor wafer is maintained at a temperature of at least 100° C during the formation of the solid layer (Col.10, lines 48 – 52).

33. Claims 33 and 45 are rejected under 35 U.S.C. 103(a) as being unpatentable over DiMeo, Jr. et al. (USPN 5,972,430) in view of Hayashi et al. (USPN 5,965,219) or Thakur (USPN 5,863,327) in further view of Murota et al. (USPN 5,705,224).

34. The combination of DiMeo, Jr. et al. and either Hayashi et al. or Thakur teach all the limitations of Claims 33 and 45 as set forth in paragraphs 31 and 32 above, except for a process wherein the semiconductor wafer is heated by a thermal heating device positioned adjacent to the wafer (Claim 33), the thermal heating device comprising an electrical resistance heater (Claim 45). It would have been obvious to

one of ordinary skill in the art to use an electrical resistance heater to heat the substrate of DiMeo, Jr. et al. as taught by Murota et al. for the reasons set forth in paragraph 26 above.

35. Claims 1 – 4, 8 – 19, and 46 – 48 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gates et al. (USPN 6,203,613 B1) in view of DiMeo, Jr. et al. (USPN 5,972,430).

36. Regarding Claim 1, Gates et al. teach a process for forming layers in electronic devices (Col.1, lines 5 – 20), the process comprising the steps of providing a reaction chamber, placing a substrate in the reaction chamber, pulsing a precursor fluid into the reaction chamber (Cols.5 – 6 and Examples 1 – 8), causing the precursor fluid to convert into a solid layer on the substrate (Examples 1 – 8), wherein the precursor fluid is substantially exhausted and removed from the reaction chamber in between each pulse of the precursor fluid (Col.6, lines 13 – 33, and Examples 1 – 8). Gates et al. also teach that this method is useful for depositing oxides and mixed oxide layers on a heated substrate (Col.7, lines 4 – 9, and Col.9, lines 20 – 44). Gates et al. do not teach exposing the precursor fluid to light energy in the reaction chamber to cause the precursor to deposit onto the substrate. DiMeo, Jr. et al. teach a similar process of depositing the same category of mixed oxide layers onto a heated substrate using ALD. DiMeo, Jr. et al. also teach that light energy can be used in addition to thermal energy to activate the deposition process (Col.10, lines 53 – 64). It would have been obvious to one of ordinary skill in the art

to couple the light energy activation taught by DiMeo, Jr. et al. with the thermal energy activation deposition process of Gates et al. with the reasonable expectation of successfully depositing the mixed oxide films of Gates et al. with the benefit of an additional light activation means as taught by DiMeo, Jr. et al.

37. The combination of Gates et al. and DiMeo, Jr. et al. teach all the limitations of Claims 2 – 4 and 8 – 19 as set forth above in paragraph 36 and below, including a method wherein:

- Claims 2 – 3 – The precursor fluid comprises either a liquid vapor or a gas (Col.6).
- Claim 4 – The substrate comprises a semiconductor wafer (Col.7, line 30).
- Claim 8 – The reaction chamber is maintained at less than atmospheric pressure. While Gates et al. is silent as to the deposition pressure, DiMeo, Jr. et al. teach that a suitable pressure for the deposition of mixed metal oxides as desired by Gates et al. is from about 0.02 to about 10 torr (i.e., less than atmospheric pressure). Therefore, it would have been obvious to one of ordinary skill in the art to choose a deposition pressure in this range and optimize the exact pressure through routine experimentation depending on the composition of the film being deposited.
- Claim 9 – The light energy is pulsed in substantial synchronization with the precursor fluid (see paragraph 23 above).

- Claim 10 – Flowing an inert gas through the reaction chamber in between pulses of the precursor fluid in order to purge the reaction chamber (Col.6 and Col.7, lines 10 – 20).
- Claims 11 – 12 – The solid layer comprises a dielectric material or a conductive material (Col.2, lines 20 – 25, Col.4, lines 40 – 51, and Examples 1 – 8).
- Claim 13 – The solid layer comprises zirconium oxide (Example 1).
- Claim 14 – The precursor fluid comprises a hydride (Col.3, line 59).
- Claim 15 – The solid layer comprises a material selected from the group consisting of tungsten, tungsten nitride, tantalum nitride, titanium nitride, copper, aluminum, ruthenium oxide, iridium oxide, and silver (Example 5).
- Claim 16 - The solid layer comprises a material selected from the group consisting of zirconium oxide, aluminum oxide, a nitride, barium strontium titanate, and a silicate (Col.9, lines 15 – 50).
- Claim 17 – The solid layer comprises zirconium hafnium oxide (Example 3).
- Claim 18 – The reaction chamber is maintained at a pressure of less than about 5 torr (see Claim 8 above).
- Claim 19 – The substrate is maintained at a temperature of at least 100° C during formation of the solid layer (Col.7, line 9).

38. The combination of Gates et al. and DiMeo, Jr. et al. teach all the limitations of Claims 46 – 48 as set forth in paragraphs 36 – 37 above.

39. Claims 5 – 7 and 49 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gates et al. (USPN 6,203,613 B1) in view of DiMeo, Jr. et al. (USPN 5,972,430) in further view of Murota et al. (USPN 5,705,224).

40. The combination of Gates et al. and DiMeo, Jr. et al. teach all the limitations of Claims 5 – 7 and 49 as set forth above in paragraphs 36 – 37 above, except for a process further comprising heating the substrate with an electrical resistance heater during the formation of the layer (Claims 5 and 49), a process wherein the reaction chamber has walls maintained at a temperature lower than the substrate during the formation of the layer (Claim 6), and a process wherein the light energy is supplied by light sources positioned outside the reaction chamber (Claim 7). Murota et al. teach these limitations, and it would have been obvious to one of ordinary skill in the art to combine the teaching of Murota et al. with the combined teaching of Gates et al. and DiMeo, Jr. et al. for the reasons set forth in paragraphs 26 – 29 above.

41. Claims 31 – 32, 34 – 35, and 37 – 44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gates et al. (USPN 6,203,613 B1) in view of DiMeo, Jr. et al. (USPN 5,972,430) in further view of Hayashi et al. (USPN 5,965,219) or Thakur (USPN 5,863,327).

42. The combination of Gates et al. and DiMeo, Jr. et al. teach all the limitations of Claim 31 as set forth in paragraphs 36 – 37 above, except for a process comprising annealing the solid layer by exposing the solid layer to light energy. However, Gates

et al. and DiMeo, Jr. et al. teach that their process is used to deposit a number of multi-component oxide films (Col.7, lines 8 – 38 of DiMeo, Jr. et al. and Col.9 of Gates et al.). Both Hayashi et al. and Thakur teach that, after depositing the type of oxide films taught by DiMeo Jr. et al. and Gates et al., it is desirable to anneal the film with UV radiation in order to increase the quality of the film and reduce the impurities in the film (Abstract and Col.6, lines 54 – 65 of Hayashi et al., and Abstract and Col.5, lines 31 – 47 of Thakur). Therefore, it would have been obvious to one of ordinary skill in the art to anneal the layers of Gates et al. with UV radiation as taught by either Hayashi et al. or Thakur with the reasonable expectation of increasing the quality of the film and reducing the impurities in the film as taught by Hayashi et al. and Thakur.

43. The combination of Gates et al., DiMeo, Jr. et al., and either Hayashi et al. or Thakur teach all the limitations of Claims 32, 34 – 35, and 37 – 44 as set forth above in paragraph 42 and below, including a method wherein:

- Claim 32 – The precursor fluid is first pulsed into the reaction chamber followed by a pulse of inert gas (Examples 1 – 8 of Gates et al.) and the light energy is emitted into the reaction chamber in synchronicity with the pulse of precursor fluid and during the annealing step but not during the pulse of inert gas (See paragraphs 23 and 31 above).
- Claim 34 – The reaction chamber is maintained at a pressure of less than about 5 torr (Col.10, line 48 of DiMeo, Jr. et al.).

Claim 35 - The reaction chamber is maintained at a pressure of less than about 3 torr (Col.10, line 48 of DiMeo, Jr. et al.).

- Claims 37 – 39 – The solid layer comprises a conductive material, a semiconductive material, or a dielectric material (Col.4 and Examples 1 – 8).
- Claim 40 – The solid layer comprises a material selected from the group consisting of tungsten, tungsten nitride, tantalum nitride, titanium nitride, copper, aluminum, ruthenium oxide, iridium oxide, and silver (Example 5).
- Claim 41 – The solid layer comprises a material selected from the group consisting of zirconium oxide, aluminum oxide, a nitride, barium strontium titanate, and a silicate (Example 3).
- Claim 42 – The semiconductor wafer is maintained at a temperature of at least 100° C during the annealing step (Col.4, lines 66 – 67, and Col.5 of Thakur).
- Claim 43 – The reaction chamber is maintained at a pressure of about 10^{-2} torr to about 10^{-7} torr when pulsing the precursor fluid into the reaction chamber (Col.10, line 48 of DiMeo, Jr. et al.).
- Claim 44 - The semiconductor wafer is maintained at a temperature of at least 100° C during the formation of the solid layer (Col.7, line 9).

44. Claims 33 and 45 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gates et al. (USPN 6,203,613 B1) in view of DiMeo, Jr. et al. (USPN 5,972,430) in

further view of Hayashi et al. (USPN 5,965,219) or Thakur (USPN 5,863,327) in further view of Murota et al. (USPN 5,705,224).

45. The combination of Gates et al., DiMeo, Jr. et al., and either Hayashi et al. or Thakur teach all the limitations of Claims 33 and 45 as set forth in paragraphs 42 and 43 above, except for a process wherein the semiconductor wafer is heated by a thermal heating device positioned adjacent to the wafer (Claim 33), the thermal heating device comprising an electrical resistance heater (Claim 45). It would have been obvious to one of ordinary skill in the art to use an electrical resistance heater to heat the substrate of Gates et al. as taught by Murota et al. for the reasons set forth in paragraph 26 above which relates to the heating of the substrate of DiMeo, Jr. et al.

46. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nishizawa et al. (USPN 5,443,033).

47. Nishizawa et al. teach all the limitations of Claim 6 as set forth in paragraph 17 above, except for a method wherein the reaction chamber has walls maintained at a temperature lower than the substrate during the formation of the layer. However, Nishizawa et al. teach the use of an electrical resistance heater that heats the substrate directly to a desired temperature (Col.4 and Figs. 1 and 10). Therefore, it would have been obvious to one of ordinary skill in the art that the walls of the reaction chamber, which are not directly heated, would have a lower temperature than the substrate, which is directly heated.

48. Claims 20 – 21, 23 – 26, and 29 – 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Utsumi et al. (USPN 5,495,822).

49. Regarding Claim 20, Utsumi et al. teach a process for forming layers in semiconductor devices comprising providing a reaction chamber, placing a semiconductor wafer in the reaction chamber, heating the semiconductor wafer with a thermal heating device placed adjacent to the wafer (Figure 3 and Col.5), pulsing a precursor fluid into the reaction chamber, the precursor fluid forming a solid layer on the semiconductor wafer (Figure 6 and Col.6, lines 1 – 30), thereafter exposing the solid layer to light energy in the reaction chamber wherein the solid layer is exposed to the light energy in between each pulse of the precursor fluid (Figure 6). Utsumi et al. do not explicitly teach that the precursor fluid is substantially exhausted and removed from the reaction chamber in between each pulse of the precursor fluid. However, Utsumi et al. do teach that while the light energy is supplied, the flow of the precursor gas is stopped (Col.5, lines 39 – 45). This is done to prevent the radiation from exciting the precursor gas to produce activated species that deposit on the substrate (Col.5, lines 46 – 49). Therefore, it would have been obvious to one of ordinary skill in the art that the precursor would have been substantially exhausted from the reaction chamber so that one would have had the reasonable expectation of preventing the unwanted production of activated species in the reaction chamber as desired by Utsumi et al. This unwanted production would inherently occur if the precursor was not substantially exhausted from the reaction chamber.

50. Utsumi et al. teach all the limitations of Claims 21, 23 – 25, and 29 – 30 as set forth above in paragraph 49 and below, including a method wherein:

- Claim 21 – The precursor fluid comprises a gas (Abstract).
- Claim 23 – The reaction chamber has walls maintained at a temperature lower than the substrate during the deposition process. While not explicitly taught by Utsumi et al., Utsumi et al. do teach that the substrate is directly heated to a predetermined temperature (Fig.5 and Col.5, lines 17 – 20). Therefore, it would have been obvious to one of ordinary skill in the art that the walls of the reaction chamber, which are not directly heated, would have a lower temperature than the substrate, which is directly heated.
- Claim 24 – The reaction chamber is maintained at a pressure of less than about 760 torr (Col.6, line 19).
- Claim 25 - The reaction chamber is maintained at a pressure of less than about 3 torr (Col.6, line 19).
- Claim 26 – An inert gas is flowed through the reaction chamber in between pulses of the precursor fluid in order to purge any remaining precursor fluid. While Utsumi et al. do not explicitly teach purging with an inert gas, Utsumi et al. do teach a desire to minimize the amount of precursor in the reaction chamber during the radiation step (Col.5, lines 46 – 49). Therefore, it would have been obvious to one of ordinary skill in the art to purge the chamber with an inert gas in between pulses of the precursor fluid in the process of Utsumi

et al. with the reasonable expectation of successfully removing the residual precursor fluid in the reaction chamber as desired by Utsumi et al.

- Claim 29 – The semiconductor wafer is maintained at a temperature of at least 100° C during formation of the solid layer (Col.7, line 29).
- Claim 30 - The reaction chamber is maintained at a pressure of from about 10^{-2} torr to about 10^{-7} torr (Col.6, line 19).

51. Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over Utsumi et al. (USPN 5,495,822) in view of Murota et al. (USPN 5,705,224).

52. Utsumi et al. teach all the limitations of Claim 22 as set forth in paragraph 49 above, except for a process wherein the thermal heating device comprises an electrical resistance heater. Utsumi et al. teach a thermal heating device in general placed adjacent to the substrate (Figure 3, reference number 4). Murota et al. teach a similar ALD process in which the substrate is successfully heated through the use of an electrical resistance heater placed adjacent to the substrate (Col.4, lines 24 – 37, and Figure 1, reference numbers 11 – 12). It would have been obvious to one of ordinary skill in the art to heat the substrate of Utsumi et al. with the electrical resistance heater of Murota et al. with the reasonable expectation of successfully heating the substrate as desired by Utsumi. et al. and taught by Murota et al. through the use of an electrical resistance heater.

Allowable Subject Matter

53. Claims 27 – 28 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

54. Claims 27 – 28 contain allowable subject matter because the prior art does not reasonably teach or suggest forming films having the composition of Claims 27 – 28 by using the method of Claim 20.

Conclusion

55. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Wesley D Markham whose telephone number is (703) 308-7557. The examiner can normally be reached on Monday - Friday, 7:30 AM to 4:30 PM.

56. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Shrive Beck can be reached on (703) 308-2333. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 305-5408 for regular communications and (703) 305-3599 for After Final communications.

57. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0661.

Wesley D Markham
Examiner
Art Unit 1762

WDM

WDM
August 21, 2001

TIMOTHY MEEKS
PRIMARY EXAMINER